# 4. The Absorption of Gamma-Rays from $Co^{60}$ in Several Elements. (II)

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The absorption measurements of gamma-rays from $Co^{60}$ (1.17 Mev and 1.33 Mv), reported in the preceding issue of this bulletin (**25**, 53 (1951)), have been further developed for many other elements. The geometrical arrangement of apparatus and procedure were the same as those described in the previous report.

The experimental results obtained are summarized in the following table comparing with the theoretically expected values, which were computed by taking into account the knowledge of photoelectric effect, Compton effect, pair production and the efficiency of the counter used for each line of gamma-rays from this isotope.

Table I. Measured absorption compared with those expected theoretically.

| Element | Linear abs. coef. $\mu$ ($cm^{-1}$) | Mass abs. coef. $\mu_m$ ($cm^2/gm$) | Atomic abs. coef. $\sigma_{Exp.}$ (barn) | Theoretical $\sigma_{Th.}$ (barn) |
|---|---|---|---|---|
| $_6C$ | 0.0884±0.0005 | 0.0589±0.0003 | 1.175±0.006 | 1.133 |
| $_{12}Mg$ | 0.0994±0.0008 | 0.0572±0.0005 | 2.307±0.020 | 2.267 |
| $_{13}Al$ | 0.1433±0.0011 | 0.0529±0.0004 | 2.378±0.018 | 2.457 |
| $_{16}S$ | 0.1121±0.0004 | 0.0567±0.0002 | 3.021±0.011 | 3.026 |
| $_{20}Ca$ | 0.0895±0.0011 | 0.0584±0.0007 | 3.887±0.046 | 3.788 |
| $_{22}Ti$ | 0.2286±0.0025 | 0.0527±0.0006 | 4.189±0.046 | 4.171 |
| $_{25}Mn$ | 0.3792±0.0096 | 0.0513±0.0013 | 4.675±0.119 | 4.750 |
| $_{26}Fe$ | 0.4076±0.0037 | 0.0519±0.0005 | 4.826±0.044 | 4.943 |
| $_{28}Ni$ | 0.4881±0.0022 | 0.0546±0.0002 | 5.324±0.024 | 5.333 |
| $_{29}Cu$ | 0.4638±0.0064 | 0.0516±0.0007 | 5.506±0.076 | 5.529 |
| $_{30}Zn$ | 0.3662±0.0027 | 0.0513±0.0004 | 5.565±0.041 | 5.726 |
| $_{34}Se$ | 0.2154±0.0017 | 0.0501±0.0004 | 6.572±0.053 | 6.523 |
| $_{42}Mo$ | 0.5268±0.0038 | 0.0514±0.0004 | 8.192±0.059 | 8.179 |
| $_{47}Ag$ | 0.5305±0.0032 | 0.0505±0.0003 | 9.046±0.055 | 9.283 |
| $_{48}Cd$ | 0.4382±0.0049 | 0.0505±0.0006 | 9.418±0.104 | 9.512 |
| $_{50}Sn$ | 0.3621±0.0035 | 0.0496±0.0005 | 9.779±0.096 | 9.971 |
| $_{51}Sb$ | 0.3349±0.0026 | 0.0500±0.0004 | 10.11±0.08 | 10.21 |
| $_{52}Te$ | 0.3042±0.0023 | 0.0487±0.0004 | 10.33±0.08 | 10.46 |
| $_{73}Ta$ | 0.8990±0.0202 | 0.0535±0.0012 | 16.06±0.36 | 16.56 |
| $_{74}W$ | 1.011±0.005 | 0.0527±0.0003 | 16.10±0.08 | 16.90 |
| $_{78}Pt$ | 1.167±0.023 | 0.0543±0.0011 | 17.61±0.34 | 18.39 |
| $_{79}Au$ | 1.074±0.005 | 0.0555±0.0003 | 18.17±0.09 | 18.78 |
| $_{80}Hg$ | 0.7493±0.0095 | 0.0553±0.0007 | 18.41±0.23 | 19.18 |
| $_{81}Tl$ | 0.6322±0.0017 | 0.0542±0.0001 | 18.53±0.05 | 19.60 |
| $_{82}Pb$ | 0.6426±0.0028 | 0.0566±0.0002 | 19.46±0.09 | 19.97 |
| $_{83}Bi$ | 0.5658±0.0025 | 0.0579±0.0003 | 20.10±0.09 | 20.42 |

It is noted that the results with the elements whose atomic numbers lie between $_{73}$Ta and $_{81}$Tl apparently differ from theory. It is improbable that this deviation would be due purely to experimental errors. If the entire deviation observed were assigned to inaccuracy in theoretical knowledge, it would be reasonable to attribute the disagreement to some insufficiency in the Klein-Nishina theory of the Compton effect, since the contribution of the photoelectric effect and pair production is much smaller than that due to the Compton effect for this energy.

Details will be published elsewhere on completion of the work.

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## 5. On the Backscattering of $\beta$-Rays from $C^{14}$ and $P^{22}$

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We have observed the phenomena of backscattering of $\beta$-rays from $C^{14}$ and $P^{32}$ with the backing of several materials by the use of an end-window G–M counter with a mica window (2.8 mg/cm$^2$). The source $C^{14}$ was mounted on a collodion film (0.1 mg/cm$^2$) and $P^{32}$ on a zapon film (0.02 mg/cm$^2$) respectively. In the latter case insulin solution was used to make uniform the thickness of the source. The source was placed about 3 cm under the window of the counter.

The experimental results obtained are as follows:

1) The amount of backscattering changes with the thickness of backing materials (Al, Pb). In each case a saturation value exists. The values are (110 ± 1)% for Al-backing with $C^{14}$, and (128 ± 1)% for Al-backing and (183 ± 1)% for Pb-backing with $P^{32}$, respectively (Table I).

2) The saturation value changes monotonously with the atomic number of the backing materials (Table II).

3) We observed the energy spectrum of $\beta$-rays from $C^{14}$ and $P^{32}$ by the absorption in Al and found that the percentage of the lower energy part increased in the case of Pb-backing (Table III).

Table I. Amount of backscattering.

| $C^{15}$ | | $P^{32}$ | | | |
|---|---|---|---|---|---|
| Al-backing (mg/cm$^2$) | percent | Al-backing (mg/cm$^2$) | percent | Pb-backing (mg/cm$^2$) | percent |
| 0.00 | 100.0 | 0.0 | 100.0 | 0.0 | 100.0 |
| 1.24 | 103.3±1.5 | 19.2 | 108.5±1 | 18.5 | 138.2±1 |
| 3.11 | 105.4±1.5 | 38.1 | 114.3±1 | 55.5 | 170.3±1 |
| 4.35 | 107.3±1.5 | 57.6 | 120.2±1 | 92.5 | 178.3±1 |
| 5.91 | 108.5±1.5 | 74.6 | 121.7±1 | 129.5 | 182.5±1 |
| 11.48 | 110.0±1.5 | 91.7 | 127.2±1 | 185.0 | 184.5±1 |